$$\text{Unknown score function } s(\boldsymbol{x},\boldsymbol{y}) \xleftrightarrow{\text{certain specification}} \text{Preference data } (\boldsymbol{x},\boldsymbol{y}_1,\boldsymbol{y}_2,c) \tag{2}$$

$$\text{Unknown score function } \mathrm{s}(\boldsymbol{x},\boldsymbol{y}) \xleftrightarrow[]{\substack{\Pr(c=1|\boldsymbol{y}_1,\boldsymbol{y}_2,\boldsymbol{x})=\sigma(s(\boldsymbol{y}_1,\boldsymbol{x})-s(\boldsymbol{y}_2,\boldsymbol{x}))\\ \text{and } s\in\mathcal{F}}} \text{Preference data } (\boldsymbol{x},\boldsymbol{y}_1,\boldsymbol{y}_2,c)$$

$$\text{Unknown score function } \mathrm{s}(\boldsymbol{x},\boldsymbol{y}) \xleftrightarrow[]{\substack{\Pr(c=1|\boldsymbol{y}_1,\boldsymbol{y}_2,\boldsymbol{x})=\upsilon(\boldsymbol{y}_1,\boldsymbol{y}_2,\boldsymbol{x}),\\ s(\boldsymbol{x},\boldsymbol{y})=\mathbb{E}_{\boldsymbol{y}'\sim\mu(\cdot|\boldsymbol{x})}[\upsilon(\boldsymbol{y},\boldsymbol{y}',\boldsymbol{x})],\\ \textbf{and } \boldsymbol{y}_1,\boldsymbol{y}_2\sim\mu(\cdot|\boldsymbol{x})}} \text{Preference data } (\boldsymbol{x},\boldsymbol{y}_1,\boldsymbol{y}_2,c)$$

The particular names of variables under expectation do not matter as long as they share the same distribution. A simple example demonstrating this point:

$$\mathop{\mathbb{E}}_{x\sim p}[f(x)] + \mathop{\mathbb{E}}_{y\sim p}[f(y)] = \mathop{\mathbb{E}}_{x\sim p}[f(x)] + \mathop{\mathbb{E}}_{x\sim p}[f(x)] = 2\mathop{\mathbb{E}}_{x\sim p}[f(x)].$$